Preview of Award 0823341 - Annual Project Report

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Accomplishments

*** What are the major goals of the project?**

The Konza Prairie LTER Program (KNZ) is a comprehensive, interdisciplinary research program with the overarching goals of contributing to conceptual and theoretical advances in the field of ecology, and providing a mechanistic and predictive understanding of ecological processes in mesic grasslands. KNZ also supports numerous educational, training and outreach activities, contributes knowledge to address land-use and management issues in grasslands, and provides infrastructure and data in support of scientific pursuits across a broad range of disciplines.

Our core research site is the Konza Prairie Biological Station (KPBS), a 3487-ha area of native tallgrass prairie in the Flint Hills of NE Kansas. KPBS was established in 1971 and joined the LTER network in 1981. LTER funding supports collection of long-term data on processes such as hydrology, nutrient cycling, plant productivity and community composition. These long-term records provide unique insights into the dynamics of tallgrass prairie ecosystems, serve as a critical baseline for identifying and interpreting ecological responses to environmental changes, and are made available as a resource for the broader scientific community. The KNZ program encompasses studies at, and across, multiple ecological levels and a variety of spatial and temporal scales. Our unifying conceptual framework focuses on fire, grazing and climatic variability as essential and interactive factors determining the structure and function of mesic grasslands. The interplay of these natural disturbances leads to the high species diversity and complex, non-linear behavior characteristic of these grasslands. Because grazing and fire regimes are managed in grasslands worldwide, KNZ data are relevant for understanding and managing grasslands globally, and for addressing broader ecological issues such as productivity-diversity relationships, disturbance and community stability, top down vs. bottom up controls of ecological processes, and the interplay of mutualistic and antagonistic biotic interactions. In addition, because human activities are directly (management of grazing and fire) and indirectly (changes in atmospheric chemistry and climate) altering key ecological drivers in these grasslands, we can use KNZ studies and data to address critical issues related to global change, including the ecology of invasions, land-use and land-cover change, human activities and water quality, and ecosystem responses to climate change. Thus, the KNZ program initiated 30 years ago to understand the effects of natural disturbances in this grassland, now has additional and immediate relevance for understanding and predicting the consequences of global change taking place in grasslands around the world.

A major goal of the KNZ LTER is the continuation of our core watershed-level fire and grazing studies, and associated long-term data collection to document both short-term and long-term dynamics in response to these treatments and a variable climate. The KNZ program is built around a long-term database on ecological patterns and processes derived from a fully replicated watershed-level experimental design, in place since 1977 with some modifications to accommodate new long-term studies initiated in LTER V and VI (e.g., the watershed-level “Fire Reversal” and "Season of Fire" experiments, the Riparian Woody Vegetation Removal experiment, the Patch-Burn Grazing Studies, and others). This unique experimental design includes replicate watersheds subject to different fire and grazing treatments, as well as a number of long-term plot-level experiments which allow us to address the mechanisms underlying responses to various fire and grazing regimes.

In addition to fire and grazing, climatic variability, climate extremes and directional climate change are key drivers of grassland dynamics, and important focal areas for KNZ activities. The effects of climate are being addressed by long-term studies encompassing the natural climatic variability, and possible directional changes, characteristic of this region, as well as manipulations of water availability and temperature in ongoing field experiments in both terrestrial (*i.e.*, the Irrigation Transect Study and the Rainfall Manipulation Plots (RaMPs) Experiment) and aquatic (i.e., Experimental Stream Studies) habitats. Within core LTER watersheds, permanent sampling transects are replicated at various topographic positions (n=4/topo. position/watershed), where ANPP, plant species composition, plant and consumer populations, soil properties, and key above- and belowground processes are measured. The collection of diverse data from common sampling locations facilitates integration among our research groups. In total, the Konza LTER Program incorporates explicit study of the major factors influencing mesic grasslands in a long-term experimental setting. It is a rigorous ecological research program designed to elucidate patterns and processes inherently important in grasslands, and address the potential impacts of global change in these ecosystems. Towards this end, we currently maintain >90 long-term datasets in association with long-term experiments ongoing as part of this program, and many more research activities of planned shorter duration.

In the 6th year (2013-2014) of this funding cycle (LTER VI, 2008-2014) we continue addressing a broad spectrum of fundamental ecological questions with an emphasis on understanding the consequences of global change for ecological dynamics in grasslands, a theme relevant to understanding, managing and conserving grasslands worldwide. Our activities focus on long-term responses to facets of global change most relevant to grasslands and grassland streams – *changes in land-use* (altered fire and grazing regimes, grassland restoration) and *land-cover* (species changes, particularly increases in woody plant cover); *climate change and altered hydrology* in both terrestrial and aquatic environments; and *altered nutrient cycles* (enhanced N deposition) – and we couple long-term observations with manipulative studies to provide mechanistic explanations for these responses. Our research also addresses biotic interactions (competition, mutualism, predation, herbivory) in grasslands, in order to provide insight into a broad range of general ecological phenomena. In total, our goals for LTER VI are to:

1. maintain and expand core LTER experiments and data sets on fire, grazing and climatic variability begun over 25 years ago, with the goal of documenting long-term responses and refining our understanding of the major abiotic and biotic factors determining grassland structure and function;

2. continue developing a mechanistic and predictive understanding of grassland dynamics and trajectories of change in response to global change drivers, using ongoing and new long-term experiments and datasets coupled with shorter-term supporting studies;

3. support and promote new synthesis activities based on our LTER results and data from other sites and studies, to use these syntheses to expand the inference of KNZ results, and to develop and test ecological theory;

4. continue education and outreach activities to make our results relevant to society.

Consistent with our goals as a long-term ecological research program, many of the long-term experiments and datasets initiated in previous LTER grants are being continued throughout the current funding period, while several new experiments and datasets were, and are, being initiated, as detailed in the original KNZ LTER VI proposal. The value of these long-term experiments and datasets continues to increase with time. In addition, results from these long-term studies have new relevance as we move towards evaluating the ecological impacts of a suite of global change phenomena occurring at the Konza LTER site and in grasslands worldwide. Below we highlight a few selected activities and findings from our most recent funding period.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

We continued the KNZ watershed-level fire experiments, and associated data collection efforts, that have been central to our “core” LTER studies since the initiation of the Konza LTER program. This includes watershed-level manipulations of fire frequencies (1, 2, 4 and 20 year fire return intervals) and seasonal timing of fires (spring, summer, autumn and winter), and experiments to assess the potential for changes in fire treatments to reverse trajectories of land-cover change (the Fire Reversal experiment). We also continued to assess the interactive effects of fire and ungulate grazers (bison and cattle) on tallgrass prairie dynamics, using data from two large-scale grazing studies. Our studies of native ungulate grazers includes 10 watersheds with different fire frequencies (1, 2, 4 and 20 year fire return intervals) grazed by a bison heard managed to remove approx. 25% of mean annual ANPP. This watershed-scale fire-grazing experiment is also used in a related NSF project (Joern, Biggs and others, 2010-2013) to assess N-driven feedbacks affecting the landscape-level distributions and foraging activity of bison and the resulting effects on spatiotemporal heterogeneity and herbivorous insects. As part of the LTER VI grant, we also initiated studies of ecological responses to alternative cattle grazing practices (traditional season-long grazing on annually burned grasslands and an alternative patch-burn grazing system designed to enhance spatial and temporal heterogeneity to achieve conservation goals). These whole watershed fire and grazing treatments are focal areas for soil, water, plant and consumer sampling, remote sensing and GIS observations, flux tower and associated sensor network measurements, and groundwater and stream monitoring networks. Many of our core LTER datasets are based on documenting long-term responses to these watershed-level manipulations. In addition, the template of watersheds with varied fire-grazing treatments and varied plant and animal communities provides a unique platform for many smaller-scale experiments, including nutrient manipulations, grazing exclosures, rainfall manipulations, species removals, etc.

In addition to the watershed treatments, we maintained or expanded several other key LTER projects in 2014. We continued several ongoing grassland restoration experiments, including adding a third set of new restoration plots in the Sequential Prairie Restoration experiment as specified in our LTER VI proposal. In addition, we expanded that project to include exclosures to assess the impact of deer browsing on community assembly in newly restored prairie communities. We also continued the Riparian Woody Plant Removal experiment initiated along 4.8 km of stream in 2011, and expanded a new LTER VI project to

document land-use and land-cover impacts on stream geomorphology. We provide greater detail about these projects and other selected research activities in the attached pdf.

Information management, and enhancing access to data and metadata, remains a priority for the KNZ LTER program. In January 2014 we hired a new Information Manager (IM), Yang Xia. Before joining the KNZ LTER program, Yang had five years of prior experience as a research and database assistant at the SEV LTER site, and nearly four years of experience as an IM and database administrator at the LTER Network Office. In her initial year as the KNZ IM she made tremendous progress in improving KNZ data availability in both the KNZ and LNO systems. She completed migration of former ASCII-based data files to the KNZ SQL database and to the NIS, and has been adding new datasets. She has also updated numerous features of the KNZ website to improve functionality, data discovery and data access. Yang also worked with KNZ investigators to optimize KNZ IM practices, including data collection and processing, and data accessibility through KNZ internal servers, the KNZ website, and the LTER NIS., Major IM activities in 2013-14 included making all KNZ data PASTA-compliant with focus on EML 2.1 integration, updating all existing KNZ data sets, and expanding the KNZ data catalog with new LTER datasets and associated metadata. Yang has also instituted a series of automated data checking procedures. We continue to offer data downloads via a variety of search and browse options in the “Data” section of our website, as both ASCII text files and SQL Server download with a query option. As a result of the activities mentioned above, the majority of our data products (approximately 80%) are now also available via the NIS data portal (a current total of 70 datasets, many of which include multiple related data packages). The KNZ IMS continues to include an up-to-date list of all KNZ LTER-supported and LTER-related publications including journal articles, conference proceedings, books and book chapters, theses and dissertations, and electronic publications. The list is searchable by key words, author name, and date. We link personnel with publications through a dynamic connection with our SQL Server database, making it easy for users to find specific personnel information and publications. We expanded our geospatial data from approx. 25 datasets to its current status of 173 geospatial data layers and associated metadata.

In May 2014, KNZ hosted the annual LTER Science Council meeting. In addition to organizing the logistics for the meeting and participating in the site-based presentations and cross-site synthesis activities, KNZ scientists organized a field trip to the Konza Prairie Biological Station (KPBS), the core site for the KNZ LTER program, and a social event at the Flint Hills Discovery Center (FHDC). The FHDC opened in 2012 as a regional center for education and outreach. The Center features videos and displays focused on the natural and social history of the Flint Hills tallgrass prairie. Because of its close ties to KNZ research, many KNZ LTER scientists serve as consultants in the development of the displays, adding a unique outreach component to the KNZ program.

Specific Objectives:

1. Continue watershed-level fire and grazing treatments and associated data collection on “core” LTER watersheds. Continue to collect, process and analyze LTER data on a suite of ecological variables from permanent sampling locations on these watersheds to assess short- and long-term responses to fire and grazing treatments, to interannual climatic variability, and to document ongoing changes in land-cover (e.g., woody plant encroachment, species turnover, species invasions) and other ecological properties and processes.

2. Continue assessing the dynamics of woody plant expansion into grasslands using long-term data from KNZ and other sites to assess thresholds and critical transitions. Couple this with short-term mechanistic studies to identify potential feedbacks that could lead to alternative stable states of grassland and woodland. In 2013-14 initiate new research on patterns of water-use among grass and woody species as they vary across environmental gradients Complete review and synthesis of tri-stability manuscript for Special Feature in Journal of Ecology (see Ratajczak et al. 2014).

3. Continue short- and long-term experiments focused on grassland responses to climatic variability and climate change. These experiments include the Irrigation Transect study (1991-present), the Rainfall Manipulation Plots (RaMPs) study (1997-present), and several shorter-term studies being done graduate students. Initiate new measurements to assess above- and below-ground plant and soil responses in the Irrigation Transect Study.

4. Continue the Patch-Burn Grazing Study (begin second rotation of fire across the three subwatershed units). Continue collection of data on animal performance, habitat heterogeneity, plant community dynamics and consumer (grasshoppers, small mammals, birds) responses.

5. Continue Riparian Woody Plant Removal study to assess the impact of woody plant expansion on grassland stream ecosystems and linkages between terrestrial and stream ecosystems. Complete analysis of 25 years of aerial photographs to rates of quantify woody plant expansion in riparian areas, and assess potential factors affecting riparian woody plant expansion (see Veach et al. 2014).

6. Continue experiments to assess responses to nutrient enrichment in both terrestrial and aquatic environments. Terrestrial nutrient enrichment experiments include the Belowground Plot Experiment (1986-present), the P-Plot Experiment (2002-present), and the NutNet Experiment (2007-present). Aquatic experiments include KNZ’s participation in the Macrosystem’s Biology SCALER project, and graduate student projects using the Experimental Stream facility at KNZ.

7. Continue to implement the Sequential Prairie Restoration Experiment, including establishment of the third stage of the restoration chronosequence in 2014. Continue sampling and data analysis of other KNZ restoration experiments as detailed in LTER VI proposal.

8. Continue to update KNZ LTER database to meet requirements for the LTER Network Information System. Provide up-to-date, accurate LTER data to KNZ investigators and to the broader scientific community as quickly and efficiently as possible.

9. Continue KNZ education and outreach activities to achieve our broader impact goals. Continue and expand SLTER on-site science activities and enlist new classes and students. Provide opportunities for undergraduate research experiences and continue to support graduate student research and training. Contribute LTER data to address relevant environmental issues (e.g., prescribed fires and air quality, land-use and water quality). Expand science and art interactions as a novel way of increasing awareness of and interest in grassland ecology and grassland conservation.

10. Conduct workshops to plan for, and prepare, the LTER VII renewal proposal due in March 2013.

Significant Results:

Core LTER experiments and datasets, many collected on watersheds with contrasting fire and grazing treatments, continued to provide unique insights into how fire and grazing independently and interactively affect ecological properties and processes in grasslands. KNZ LTER data on plant productivity, soil processes, plant community structure, consumer population dynamics, and related data sets were also used for both site-specific and cross-site analyses (e.g., scaling and modeling activities, response to regional climate gradients or local climatic variability, etc.). Here we highlight just a few recent results, with additional details about these and other studies provided in the attached pdf file and in our publication and products list.

Grassland-woodland transitions: Changes in land-use and land-cover are major threats to grasslands globally. KNZ watersheds with contrasting fire and grazing regimes, in place for over 30 years, serve as a laboratory for exploring the dynamics, causes and consequences of woody plant encroachment into grasslands. We identified ecological thresholds of 3-year fire returns and ~60% grass cover, based on analysis of long-term data from KNZ fire and grazing experiments, coupled with a suite of shorter-term mechanistic field studies (Ratajczak et al. 2014a). When tallgrass prairie is pushed passed these thresholds, it can undergo relatively rapid transition to self-reinforcing shrubland or woodland states (Ratajczak et al. 2014b). Demographic bottlenecks, niche partitioning, and altered fire feedback mechanisms account for both the non-linear nature of grassland-shrubland transitions and the resistance of established shrublands to fire and drought. Woody plant expansion also impacts grassland streams, with headwater streams within tallgrass prairies becoming forested due to rapid conversion of riparian zones from grassy to wooded. We estimated the rate of riparian woody plant expansion within a 30 m buffer zone surrounding the stream bed across whole watersheds at Konza Prairie Biological Station over 25 years from aerial photographs (Veach et al. 2014). Fire frequency, presence or absence of grazing bison, and the historical presence of woody vegetation prior to the study period were used to predict rates of riparian woody plant expansion between 1985 and 2010. Riparian woody encroachment rates increased with burning less frequent than every 2 years. Higher fire frequencies (1–2 years) did not reverse riparian woody encroachment regardless of whether woody vegetation was present or not before burning regimes were initiated. Overall, burning regimes with a frequency of every 1–2 years will slow the conversion of tallgrass prairie stream ecosystems to forested ones, yet over long time periods, riparian woody plant encroachment may not be prevented by fire alone, regardless of frequency.

Assessing convergence and contingencies in grassland responses to fire and grazing: We use long-term fire and grazing studies at KNZ to assess similarities and differences in the responses of other mesic grasslands to fire and grazing, with a current focus on South African grasslands. Forrestel et al. (2014) assessed phylogenetic and functional responses of plant communities to fire at KNZ and Kruger National Park (KNP). They examined grassland communities in response to experimentally manipulated fire regimes at multiple levels of diversity (taxonomic, phylogenetic and functional) in mesic savanna grassland sites dominated by perennial C4 grasses and with similar structure and physiognomy, but disparate biogeographic histories. They identified convergent phylogenetic and functional responses to altered fire regimes. They found that the grass communities were similar in their phylogenetic response and aspects of their functional response to high fire frequency. Both sites exhibited phylogenetic clustering of highly abundant species in annually burned plots, driven by species of the Andropogoneae, and a narrow range of functional strategies associated with rapid post-fire regeneration in a high-light, N-limited environment. These results highlight the importance of a common filtering process associated with fire that is consistent across grasslands of disparate biogeographic histories and taxonomic representation. Koerner et al. (2014) assessed the impacts of large grazers on grassland communities by excluding large herbivores for seven years from mesic savanna grasslands sites burned at KNZ and KNP. After 7 years of large-herbivore exclusion, richness strongly decreased and community composition changed at KNZ, but there was little change at KNP. This divergence in response was attributed to differences in the traits and numbers of dominant grasses between the study sites rather than differences in herbivore assemblages. Diversity of large herbivores may be less important in determining plant community dynamics and responses to grazing than the functional traits of the dominant grasses.

Effects of genetic diversity of dominant grasses: Both species diversity and genetic diversity within a dominant species can affect plant productivity. However, these two levels of diversity may affect productivity in opposing ways. Chang and Smith (2014) assessed direct and indirect relationships between genetic diversity of a dominant grass species and plant community diversity on productivity at KNZ. With frequent burning, the dominant C4 grass, *Andropogon gerardii,* was more abundant; in contrast, infrequently burned sites typically have higher species diversity but lower abundance of *A. gerardii*. Therefore, they hypothesized that genetic diversity within *A. gerardii* would have a significant direct relationship with productivity for the frequently burned site due to higher population abundances of *A. gerardii* overall*,* whereas species diversity would have a significant direct relationship with productivity for the infrequently burned site. Contrary to predictions, genetic diversity of *A. gerardii* was not related to above-ground productivity either directly or indirectly via traits, while diversity at the community level had an indirect negative relationship with productivity via a negative effect of *A. gerardii* abundance on community diversity for both frequently and infrequently burned sites. These results point to the need for studies that examine the indirect and potentially interactive effects of both levels of diversity in natural communities.

Responses to nutrient enrichment: Previous studies have shown that N enrichment increases terrestrial ecosystem ANPP, but reduces plant diversity and alters plant community composition. However, less is known about the effects of P additions and interactions between N and P are understudied. We initiated a new KNZ experiment (the P-Plot Experiment) in 2002 to address the short- and long-term effects of P and N enrichment in a high-diversity biennially-burned tallgrass prairie. After a decade of nutrient additions, Avolio et al. (2014) found few effects of P alone on plant community composition, stronger effects of N alone, and N and P additions combined resulted in much larger effects than either alone. Changes in the plant community were driven by decreased abundance of C4 grasses, perhaps in response to altered interactions with mycorrhizal fungi, concurrent with increased abundance of non-N-fixing perennial and annual forbs. Surprisingly, this shift in plant community composition had little effect on plant community richness, evenness and diversity, but did have large and variable effects on ANPP. ANPP was more temporally variable, with pulses in forb production only in years when the site was burned (i.e., large shifts in species composition increased variability in ANPP over time in response effects of biennial burning). Increased inputs of N and P to terrestrial ecosystems have the potential to alter stability of ecosystem function over time, particularly within the context of natural disturbance regimes.

Key outcomes or Other achievements: See significant results and impact sections for discussions of specific key research outcomes and acheivements. In addition, we view the successful planning and renewal of the KNZ LTER program in 2014 as a one of our major acheivements in the past year.

*** What opportunities for training and professional development has the project provided?**

Graduate student training continues to be an important component of our LTER program. During this funding period, we provided stipends and/or other support (computer, laboratory, field vehicles, etc.) for >20 graduate students. In addition to KSU students, the Konza Prairie site continues to be used by graduate students from a number of other U.S. institutions including in 2013-14: Colorado State University (David Hoover, Kevin Wilcox, Ashley Shaw, Jenny Song), Cornell University (Rebecca Lohnes), Southern Illinois University (Karen Jackson, Logan Shoup ,George Manning Tianjiao Adams, Drew Scott), Oklahoma State University (Mitchell Greer, Sally Kittrell, Parker Coppick and Laura Mino), University of Kansas (Huan Liu, Michael Rawitch), among others.

The Konza LTER program also offers research experiences for a large number of undergraduate students. In 2014, we supported 2 LTER REU students with supplements, and contributed additional support to the KSU/Konza REU site program. Summer 2014 was the 19th year that Konza Prairie and the Division of Biology at K-State have offered a 10-week summer undergraduate research program. Participants in the structured program included 10 students supported by NSF-funded REU Site and Supplements, and 7 students supported by a related NSF-funded Undergraduate Research Mentoring (URM) program, being co-led by LTER investigator Ari Jumpponen. While research at the KNZ site is not mandatory for URM students, many URM students do conduct a portion of their research there. Examples of these projects include: distribution of crickets (*Allonemobius socius*, *A*. sp. nov. Tex, and *A. shalontaki*) to identify areas of sympatry; species richness, diversity, and community composition of mycorrhizal fungi inhabiting native and non-native hosts; and, phenology and morphological variability of *Andropogon gerardii*. The KSU URM program also integrates with the Konza Prairie LTER site REU program. Among the examples of these integration activities are: URM/REU mentor seminars to the REU and URM students; URM student presentations in REU grand finale symposium; shared data blitz in the Ecological Genomics forum; concurrent ethics training; and, participation in Konza Prairie LTER workshop.

Formal educational activities at the K-12 level began with the initiation of the Konza Environmental Education Program (KEEP) in 1996, and were greatly expanded with the initiation of the Konza Prairie Schoolyard LTER (SLTER) in 1998. The Konza Prairie Schoolyard LTER (SLTER) program is now entering its 16th year as a science education program for K-12 teachers and their students, built around the successful Konza Prairie LTER program. Our SLTER program continues to prosper with input from Konza LTER PIs and Kansas K-12 educators. The Konza Prairie SLTER program aims to educate students about ecology and global change, with emphasis on regional grasslands, by engaging students and teachers in realistic and relevant science-based activities focused on long-term data collection at our LTER site. These activities were designed to give students an understanding of ecology, provide them the opportunity to collect and interpret their own data, and integrate their data into our long-term SLTER databases via the Internet (keep.konza.ksu.edu). By sharing knowledge generated through long-term data collections we give teachers tools for connecting children to locally and regionally important ecosystems.

In 2014 we added five new teachers to our roster of SLTER-trained instructors, bringing the total number of trained area teachers to 91. These workshops serve to initiate new teachers into the Konza SLTER program. Teachers experience all of the science activities first-hand and are then assisted in the development of new curriculum that incorporates a class' visit to the Konza Prairie. The workshops are the single strongest tool we have

to sell new teachers on the science education available to their students. In 2013 1,166 students participated in a SLTER activity. The impact of the Konza Environmental Education Program continues to grow within the community. In 2013 we began a partnership with the Manhattan/Ogden School District 383 to be an available source of informal education – specifically addressing certain common core concepts that are easily experienced during a nature trail hike. Additionally, we have another partnership with the Flint Hills Discovery Center to co-host school groups. Konza Prairie also maintains an active and enthusiastic group of volunteer docents who assist with the Environmental Education Program. Every year a group of 10 – 20 new docents are added to the group and these volunteers receive approximately 40 hours of in-depth training and education on the ecology, history, geology, and management of Konza Prairie and the tallgrass prairie. In exchange for this training they agree to volunteer their time and knowledge to the educational program and to the needs of the biological station. They are the first responders to requests for guided tours and educational opportunities and provide an invaluable resource to our site. In 2013, the docents provided 1,882 volunteer hours for guiding hikes and science activities.

One aspect of docent training is continuing education. Once a docent graduates after their year of training they are expected to maintain their education by attending lectures and seminars that are pertinent to their roles as Konza volunteers. Both the docent training and the continuing education seminars are recorded and available on the Konza Channel on YouTube.com. In 2013, there were 76 videos that were viewed a total of 1,932 times. These videos are not restricted and they are also used by the general public.

*** How have the results been disseminated to communities of interest?**

Konza LTER results are disseminated to the scientific community via publications in the peer-reviewed literature, through presentations at professional meetings and workshops, through seminars by KNZ scientists and students and via the KNZ and LNO LTER web sites. In addition, KNZ scientists have participated in a broad range of activities that go beyond the scientific community. For example, KNZ data and findings are used in a number of undergraduate and graduate ecology courses at Kansas State University, the University of Arizona, Colorado State University, and Ohio University, among others. In addition, KNZ findings are increasingly utilized in undergraduate ecology texts and supplementary teaching materials. For example, KNZ long-term studies are used to demonstrate the role of fire and grazing in grasslands in
'General Ecology, 2nd edition' by D.T. Krohne, and as an example of the importance of long-term research in the 'Ecology' text by Cain et al. A recent KNZ study by Collins et al. is featured as a 'case study' in the on-line supplement to 'Ecology. Theory and Applications. 3rd edition' by P. Stiling. KNZ studies on top-down regulation of plant community structure are featured in an introductory undergraduate biology text ('Life. The Science of Biology. 7th edition' by Purves, Sadava, Orians and Heller) and KNZ data and findings are highlighted in several upper-level and graduate texts including 'Freshwater Ecology' (W.K. Dodds), 'The Ecology of Plants' (Gurevitch, Scheiner and Fox), and 'Biogeochemistry. An Analysis of Global Change' (W.H. Schlesinger). KNZ graduate students and PIs have also co-authored several educational publications, based on LTER data, for the peer-reviewed ESA-supported Teaching Issues and Experiments in Ecology (TIEE) and other education-based outlets.

This year KNZ research activities and findings were also highlighted in biennial Konza Visitor's Day (September 27, 2014), attended by approximately 1000 people.

*** What do you plan to do during the next reporting period to accomplish the goals?**

We are currently entering a final no-cost extension year for the LTER VI funding cycle while simultaneously transitioning to the newly funded LTER VII grant. We plan to use this period (Nov 2014-Oct 2015) to: 1) complete the collection and processing of samples from 2014; 2) continue data processing, data error checking and the entry of data into the KNZ LTER database and the LTER Network Information System; 3) continue publication of results based on KNZ LTER experiments and data; and 4) ensure a smooth transition to new and continuing activities in the LTER VII funding cycle.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Konza Activities 2014.pdf	Summary of some additional major KNZ LTER activities for the 2013-14 reporting period.	John Blair	11/17/2014
KNZ LTER FINDINGS.pdf	Summary of selected additional KNZ LTER findings for the 2013-14 reporting period	John Blair	11/17/2014

Products

Books

Book Chapters

Blair J.M., J. Nippert and J. Briggs. (2014). Grassland Ecology. In. *The Plant Sciences - Ecology and the Environment* R. Monson. SpringerReference. Springer-Verlag. Berlin Heidelberg. . Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = No

Conference Papers and Presentations

Inventions

Journals

Alexander, H.A., K.E. Mauck, A.E. Whitfield, K.A. Garrett, and C.M. Malmstrom (2014). Plant-virus interactions and the agro-ecological interface. *European Journal of Plant Pathology*. 138 529. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Avolio, M., C.C. Chang, J.J. Weis, and M.D. Smith (2014). The effect of genotype richness and genomic dissimilarity of Andropogon gerardii on invasion resistance and productivity. *Plant Ecology and Diversity*. . Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ;

DOI: 10.1080/17550874.2013.866990

Avolio, M.L. and M.D. Smith (2013). Correlations between genetic and species diversity: effects of resource quantity and heterogeneity. *Journal of Vegetation Science*. 24 1185. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Avolio, M.L. and M.D. Smith. (2013). Mechanisms of selection: Phenotypic differences among genotypes explain patterns of selection in a dominant species.. *Ecology*. 94 953. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Avolio, M.L., S.E. Koerner, K.J. La Pierre, K.R. Wilcox, M.D. Smith, and S.L. Collins (2014). Changes in plant community composition, not diversity, during a decade of nitrogen and phosphorus additions drive above-ground productivity in a tallgrass prairie.. *Journal of Ecology.*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

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Licenses

Other Products

Other Publications

Sandercock, B.K., S.M. Wisely, L.B. McNew, A.J. Gregory, V.L. Winder, and L.M. Hunt. (2013). *Environmental impacts of wind power development on the population biology of Greater Prairie-Chickens. U.S. Department of Energy, Final Project Report for Award DOE/EE0000526 (technical report).*. Final Project Report for Award DOE/EE0000526 (technical report).. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

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Patents

Technologies or Techniques

Thesis/Dissertations

Troia, M.J.. *A mechanistic framework for understanding prairie stream fish distributions.*. (2014). Kansas State University. Manhattan, KS.. Acknowledgement of Federal Support = Yes

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Klopf, R.P.. *Community and ecosystem changes in tallgrass prairie restorations: the effects of population source and diversity.*. (2013). Southern Illinois University. Carbondale, IL.. Acknowledgement of Federal Support = Yes

Chang, C.C. *Dimensions of diversity and their direct and indirect effects on tallgrass prairie ecosystem functioning*. (2012). Yale University. New Haven, CT. Acknowledgement of Federal Support = Yes

Ott, J.P.. *Ecological implications of grass bud bank and tiller dynamics in mixed-grass prairie.*. (2014). Kansas State University. Manhattan, KS.. Acknowledgement of Federal Support = Yes

Hoover, D.L.. *Ecological responses to climate extremes in a mesic grassland.*. (2014). Colorado State University. Fort Collins, CO.. Acknowledgement of Federal Support = Yes

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Sousa, B.F. *Ecology of mating patterns and sexual selection in dickcissels breeding in managed prairie*. (2012). University of Kentucky. Lexington, KY. Acknowledgement of Federal Support = Yes

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Liu, H.. *Inorganic and organic carbon variations in surface water, Konza Prairie LTER Site, USA, and Maolan Karst Experimental Site, China.*. (2014). University of Kansas. Lawrence, KS.. Acknowledgement of Federal Support = Yes

Vandermyde, J. *Macroinvertebrate responses to removal of riparian woody vegetation along tallgrass prairie streams*. (2013). Southern Illinois University. Carbondale, IL. Acknowledgement of Federal Support = Yes

Killian, P.D. *Mechanisms driving woody encroachment in the tallgrass prairie: an analysis of fire behavior and physiological integration*. (2012). Kansas State University. Manhattan, KS. Acknowledgement of Federal Support = Yes

Soong, J.. *Moving beyond mass loss: Advancing understanding about the fate of decomposing leaf litter and pyrogenic organic matter in the mineral*

soil.. (2014). Colorado State University. Fort Collins, CO.. Acknowledgement of Federal Support = Yes

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Larson, D.M.. *The influence of fire and grazing on tallgrass prairie streams and herpetofauna.*. (2014). Kansas State University. Manhattan, KS.. Acknowledgement of Federal Support = Yes

Sylvain, Z.L.. *The influence of moisture availability on terrestrial ecosystems: Effects on soil animal communities along a regional/global-scale climate gradient.*. (2013). Colorado State University. Fort Collins, CO.. Acknowledgement of Federal Support = Yes

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Denton, E.. *When a drought is not a drought: Timing determines productivity responses to drought in a mesic grassland.*. (2014). Colorado State University. Fort Collins, CO.. Acknowledgement of Federal Support = Yes

Olstad, T.A. *Zen of the Plains: discovering space, place, and self*. (2012). Kansas State University. Manhattan, KS. Acknowledgement of Federal Support = Yes

Websites
Konza Prairie LTER project website
http://www.konza.ksu.edu/knz/pages/home/home.aspx

This is the main website for the KNZ LTER program, and includes links to the KNZ documents, databases, and publications.

Participants/Organizations

Research Experience for Undergraduates (REU) funding

Form of REU funding support:	REU supplement
How many REU applications were received during this reporting period?	4
How many REU applicants were selected and agreed to participate during this reporting period?	2
REU Comments:	

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Blair, John	PD/PI	4
Dodds, Walter	Co PD/PI	2
Hartnett, David	Co PD/PI	2
Joern, Anthony	Co PD/PI	2
Nippert, Jesse	Co PD/PI	2
Baer, Sara	Co-Investigator	2
Briggs, John	Co-Investigator	1
Collins, Scott	Co-Investigator	1
Daniels, Melinda	Co-Investigator	1
Ferguson, Carolyn	Co-Investigator	1
Gido, Keith	Co-Investigator	1

Name	Most Senior Project Role	Nearest Person Month Worked
Goodin, Douglas	Co-Investigator	1
Harrington Jr., John	Co-Investigator	1
Horne, Eva	Co-Investigator	1
Hutchinson, Stacy	Co-Investigator	1
Jensen, William	Co-Investigator	1
Johnson, Loretta	Co-Investigator	1
Jumponnen, Ari	Co-Investigator	1
Kaufman, Donald	Co-Investigator	1
Knapp, Alan	Co-Investigator	2
Macpherson, Gwendolyn	Co-Investigator	2
Olson, KC	Co-Investigator	2
Rice, Charles	Co-Investigator	1
Sandercock, Brett	Co-Investigator	1
Smith, Melinda	Co-Investigator	2
Whiles, Matt	Co-Investigator	1
Wilson, Gail	Co-Investigator	1
Zolnerowich, Gregory	Co-Investigator	1
Avolio, Meghan	Postdoctoral (scholar, fellow or other postdoctoral position)	2
Haukos, Jill	Other Professional	12
Xia, Yang	Other Professional	9
Kuhn, Thomas	Technician	3
Voth, Aaron	Technician	9
Towne, Gene	Staff Scientist (doctoral level)	12
Adams, Tianjiao	Graduate Student (research assistant)	3
Costigan, Katie	Graduate Student (research assistant)	6
Erndt, Kim	Graduate Student (research assistant)	9
Forrestel, Elisabeth	Graduate Student (research assistant)	2
Gomez, Jesus	Graduate Student (research assistant)	12
Greer, Mitchell	Graduate Student (research assistant)	3
Grudzinski, Bart	Graduate Student (research assistant)	12

Name	Most Senior Project Role	Nearest Person Month Worked
Harris, Patrick	Graduate Student (research assistant)	3
Hoover, David	Graduate Student (research assistant)	3
Horton, AJ	Graduate Student (research assistant)	3
Jackson, Karen	Graduate Student (research assistant)	3
LaPierre, Kimberly	Graduate Student (research assistant)	2
Larson, Danelle	Graduate Student (research assistant)	9
Liu, Huan	Graduate Student (research assistant)	2
Manning, George	Graduate Student (research assistant)	3
Ott, Jacquiline	Graduate Student (research assistant)	6
Ratajczak, Zak	Graduate Student (research assistant)	12
Raynor, Edward	Graduate Student (research assistant)	12
Ricketts, Andrew	Graduate Student (research assistant)	12
Scott, Drew	Graduate Student (research assistant)	4
Song, Jennifer	Graduate Student (research assistant)	3
Stanton, Nicole	Graduate Student (research assistant)	12
Vandermyde, Jodi	Graduate Student (research assistant)	9
VanderWeide, Ben	Graduate Student (research assistant)	9
Veach, Alison	Graduate Student (research assistant)	12
Verheijen, Bram	Graduate Student (research assistant)	12
Welti, Ellen	Graduate Student (research assistant)	12
West, Ray	Graduate Student (research assistant)	3
Wilcox, Kevin	Graduate Student (research assistant)	4
Kuhl, Amanda	Non-Student Research Assistant	12
O'Neal, Patrick	Non-Student Research Assistant	12
Ramundo, Rosemary	Non-Student Research Assistant	12
Taylor, Jeff	Non-Student Research Assistant	12
Atwell, Taylor	Undergraduate Student	2
Cook, Kevin	Undergraduate Student	4
Delaroy, Jeffrey	Undergraduate Student	2
Harris, Grady	Undergraduate Student	3

Name	Most Senior Project Role	Nearest Person Month Worked
Heimbach, Luc	Undergraduate Student	4
McChesney, Alexandria	Undergraduate Student	6
Meadors, Henry	Undergraduate Student	4
Meyer, Nick	Undergraduate Student	2
Mortensen, Severin	Undergraduate Student	6
Noel, Eric	Undergraduate Student	3
Nunnenkamp, Hunter	Undergraduate Student	1
Orozco, Gracie	Undergraduate Student	3
Samms, Grant	Undergraduate Student	4
Wendt, Nathan	Undergraduate Student	3
Wiber, Nick	Undergraduate Student	4
Wiens, Eric	Undergraduate Student	3
Wilson, Nick	Undergraduate Student	1
Zuercher, John	Undergraduate Student	3
Ketter, Benjamin	Research Experience for Undergraduates (REU) Participant	3
Patton, Mariah	Research Experience for Undergraduates (REU) Participant	3
Pennock, Cassey	Research Experience for Undergraduates (REU) Participant	3

Full details of individuals who have worked on the project:

John M Blair
Email: jblair@ksu.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: Dr. Blair is the Konza Prairie LTER lead PI and project director. Provides overall LTER project leadership and coordination. Research expertise in ecosystem ecology and terrestrial biogeochemistry; soil ecology, including decomposition, soil nutrient cycling, litter/soil/plant nutrient dynamics; effects of climate change and other disturbances on ecosystem processes; ecology of soil invertebrates; and restoration ecology.

Funding Support: None

International Collaboration: No
International Travel: No

Walter K Dodds
Email: wkdodds@ksu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: Konza LTER VI Co-PI. Dr. Dodds provides leadership for the Konza LTER aquatic research group. Research expertise in aquatic ecology; phycology; nutrient cycling and retention in streams; groundwater chemistry; watershed-level hydrologic export; water quality. Dr. Dodds is also leading the new riparian vegetation removal study as part of the LTER VI funding cycle. This study will assess the impacts of riparian land-cover change on grassland streams.

Funding Support: NSF Macrosystem Project: Scale, consumers, and Lotic Ecosystem Rates (SCALER): from decimeters to continents

International Collaboration: No
International Travel: No

David C Hartnett
Email: dchart@ksu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: Konza LTER VI Co-PI and former Director of the Konza Prairie Biological Station (the primary research site for the Konza LTER program). Expertise in grassland plant population ecology; the role of belowground bud banks in grassland communities; plant mycorrhizal interactions in grasslands; plant-herbivore interactions; fire ecology. Also involved in ILTER activities, and Co-Director of the Institute for Grassland Studies.

Funding Support: None

International Collaboration: Yes, Botswana
International Travel: No

Anthony Joern
Email: ajoern@ksu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: Konza LTER VI Co-PI. Provides expertise on insect population and community studies; plant-herbivore-predator interactions; long-term consumer population dynamics; responses of insect herbivores to fire and grazing; temporal dynamics in ecological studies. Oversees the Konza LTER tong-term grasshopper abundance dataset, and studies on the role of insect herbivores and climate change in mesic grasslands. Is leading the new LTER VI patch-burning grazing study, and assessing impacts of fire-grazing interactions on spatial patterning. Co-Director of the KSU Institute for Grassland Studies (with D. Hartnett).

Funding Support: NSF: Impacts of Spatially Heterogeneous Nitrogen to Grazer Distribution and Activity: Effects on Ecosystem Function in Tallgrass Prairie

International Collaboration: No
International Travel: No

Jesse B Nippert
Email: nippert@ksu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 2

Contribution to the Project: Dr. Nippert is a co-PI on the Konza LTER VI project, and contributes expertise in plant ecology and ecophysiology, and plant responses to environmental variability and change. Dr. Nippert oversees the application of environmental sensor networks to assess spatial variability in microclimate, and plant responses on core LTER watersheds at the Konza Prairie LTER site. He also directs the KSU Stable Isotope Mass Spectroscopy Laboratory, and provides expertise on the application of stable isotopes to ecological studies. Funding Support: none

Funding Support: None

International Collaboration: No
International Travel: No

Sara Baer
Email: sgbaer@siu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Dr. Baer provides expertise on grassland restoration, particularly with respect to plant community dynamics and long-term changes in ecosystem properties and processes. She is responsible for directing research on grassland restoration ecology at the Konza site, including recovery of ecosystem properties in restored grasslands, and the influence of genotypic differences in cultivars and native vegetation on ecological processes in restored grasslands. Dr. Baer oversees the new Restoration Chronosequence study being initiated as part of the LTER VI project. Supported with a subcontract to Southern Illinois University.

Funding Support: none

International Collaboration: No
International Travel: No

John M Briggs
Email: jbriggs1@k-state.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Konza LTER investigator and Director of the Konza Prairie Biological Station (the primary research site for the Konza LTER program). Dr. Briggs oversees studies of grass-shrub interactions and the causes and consequences of woody plant encroachment into grasslands. Directs research into patterns and controls of ANPP in grasslands, as well as studies of the relationship between ANPP and species richness. Also provides expertise in database management, GIS and remote sensing studies.

Funding Support: NSF: Impacts of Spatially Heterogeneous Nitrogen to Grazer Distribution and Activity: Effects on Ecosystem Function in Tallgrass Prairie

International Collaboration: No
International Travel: No

Scott Collins
Email: scollins@sevilleta.unm.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Expertise in grassland ecology and plant community ecology; ecological analyses of spatial and temporal dynamics; ecological responses to disturbance; analysis of species distribution and abundance; local-regional interactions; productivity-diversity relationships.

Funding Support: NSF Savannah Convergence Project

International Collaboration: Yes, South Africa
International Travel: Yes, South Africa - 0 years, 0 months, 10 days

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Melinda Daniels
Email: mddaniel@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Melinda Daniels is an Associate Professor of Geography and new senior personnel with the Konza LTER program. Her research expertise is in fluvial geomorphology and she has initiated new measurements of stream morphology, erosion and sediment transport at the Konza Prairie LTER site.

Funding Support: Missouri Department of Conservation grant: Biotic integrity of prairie streams as influenced by patch burn grazing and riparian protection

International Collaboration: No
International Travel: No

Carolyn Ferguson
Email: ferg@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Expertise in plant systematics, plant population biology, and plant-pollinator interactions. Dr. Ferguson oversees the KSU Herbarium, and also provides expertise on electronic databasing of biological collections. Dr. Ferguson is also PI of GK-12 grant, which includes students and faculty scientists from the Konza LTER program.

Funding Support: none

International Collaboration: No
International Travel: No

Keith Gido
Email: kgido@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides expertise in aquatic ecology; stream communities and ecosystems; the effects of fish on stream ecosystem properties such as primary productivity, nutrient cycling, community structure (species richness and diversity), decomposition and transport of particulate organic matter (POM); impacts of altered hydrologic regimes on stream ecosystems. Oversees the LTER experimental stream facility. Coordinates regional assessments of stream fish communities.

Funding Support: NSF Macrosystem Project: Scale, Consumers, and Lotic Ecosystem Rates (SCALER): from decimeters to continents NSF Dissertation Research: Forecasting Global Warming Effects on Developmental Performance of Prairie Stream Fishes along the River Continuum.

International Collaboration: Yes, Australia
International Travel: No

Douglas Goodin
Email: dgoodin@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides expertise on remote sensing of ecological data, including patterns of plant productivity and spatial distributions of grazing and fire effects; research on climatology in the Central Plains (Dr. Goodin serves on the LTER Climate Committee); research on the impacts of burning on air quality.

Funding Support: NSF: Impacts of Spatially Heterogeneous Nitrogen to Grazer Distribution and Activity: Effects on Ecosystem Function in Tallgrass Prairie

International Collaboration: No
International Travel: No

John Harrington Jr.
Email: jharrin@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Harrington is a Professor of Geography with expertise in climatology and climate change, land-use/land-cover change, and natural resource applications of remote sensing and GIS. Dr. Harrington is leading many of the new social science related initiatives within our LTER program, and has been representing the KNZ LTER program at numerous LTER Network social science planning and cross-site activities (valuation of ecosystem services, impacts of land-cover change, etc.).

Funding Support: none

International Collaboration: No
International Travel: No

Eva Horne
Email: ehorne@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Research in behavioral ecology of grassland reptiles; responses of reptile and amphibian populations to fire and grazing. Dr. Horne also assists with administration of the Konza Prairie Biological Station, and coordination of research permits and projects at the site.

Funding Support: none

International Collaboration: No
International Travel: No

Stacy Hutchinson
Email: sllhutch@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Hutchinson is a Professor of Biological and Agricultural Engineering, and has assumed responsibility for overseeing the water addition treatments and soil moisture monitoring in the long-term Irrigation Transect Experiment at the Konza site. This was previously the responsibility of Dr. Jim Koelliker until his retirement in 2010

Funding Support: none

International Collaboration: No
International Travel: No

William Jensen
Email: wjensen1@emporia.edu

Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Dr. Jensen is an Associate Professor at Emporia State University. He is studying the effects of patch-burn grazing on brood parasitism of Dickcissel nests in the Flint Hills tallgrass prairie, and is responsible for collecting data on avian consumer responses to the patch-burn grazing experiment..

Funding Support: none

International Collaboration: No
International Travel: No

Loretta Johnson
Email: johnson@k-state.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides research expertise in plant ecology, plant-soil interactions, and ecological genomics. Oversees a long-term water x N amendment experiment at Konza Prairie, and a cross-site study of the impacts of climate on success of local vs. non-local ecotypes of dominant grasses.

Funding Support: none

International Collaboration: No
International Travel: No

Ari Jumponnen
Email: ari@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Expertise on fungal ecology, particularly mycorrhizae and other endophytic fungi; diversity of soil microbial communities; application of molecular methods to characterize soil microbial communities.

Funding Support: none

International Collaboration: No
International Travel: No

Donald Kaufman
Email: dwkaufman@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Research focus is on the ecology of small mammals, and temporal and spatial dynamics of consumer populations in grasslands.

Funding Support: none

International Collaboration: No
International Travel: No

Alan Knapp
Email: alan.knapp@colostate.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Provides research expertise in grassland ecology, plant ecology, physiological ecology, global change studies, plants-herbivore interactions, invasive species ecology. Dr. Knapp also provides leadership for LTER studies of plant productivity and responses to climatic variability and climate change, and conducts multi-site research involving SGS and KNZ LTER sites. Supported by a subcontract to Colorado State University.

Funding Support: NSF Savannah Convergence Project

International Collaboration: Yes, South Africa
International Travel: Yes, South Africa - 0 years, 0 months, 10 days

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Gwendolyn Macpherson
Email: glmac@ku.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Expertise in hydrogeology; subsurface hydrology; long-term studies of groundwater flux and biogeochemistry at Konza LTER site. Supported by a subcontract to the University of Kansas.

Funding Support: none

International Collaboration: No
International Travel: No

KC Olson
Email: kcolson@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: KC Olson is a professor of animal science, who brings expertise on the physiology and management of cattle in mesic grasslands. Dr. Olson is an active participant in the new patch-burn grazing study, and will oversee assessment of animal performance as a management-related aspect of this LTER study.

Funding Support: none

International Collaboration: No
International Travel: No

Charles Rice
Email: cwrice@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Expertise in soil microbial ecology; responses of grassland microbial communities to fire, grazing climatic variability; soil C and N dynamics; denitrification in grasslands; effects of management on soil C sequestration. Contributor and author for IPCC AR4.

Funding Support: none

International Collaboration: No
International Travel: No

Brett Sandercock
Email: bsanderc@ksu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Expertise in avian population ecology and conservation biology. Dr. Sandercock oversees long-term sampling of grassland bird populations at the Konza LTER site, and conducts research on factors that influence population dynamics of grassland bird species. Also collaborating with researchers in Uruguay to study population dynamics of Upland Sandpipers, a migratory bird species that breeds in North American tallgrass prairies. Co-PI for Konza Prairie site-based REU program during LTER VI.

Funding Support: none

International Collaboration: No
International Travel: No

Melinda Smith
Email: melinda.smith@colostate.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: Associate Professor at Colorado State University conducting research on plant population and community dynamics at Konza Prairie, and the impacts of climate change. Directs site-based activities related to the multi-site Nutrient Network (NutNet) project.

Funding Support: NSF Savannah Convergence Project

International Collaboration: No
International Travel: Yes, South Africa - 0 years, 0 months, 10 days

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What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Colorado State University	Academic Institution	Fort Collins, CO
Kansas State of	State or Local Government	Topeka, Kansas
National Oceanic and Atmospheric Administration (NOAA)	Other Organizations (foreign or domestic)	USA
Oklahoma State University	Academic Institution	Stillwater, OK
Southern Illinois University at Carbondale	Academic Institution	Carbondale, IL
The Nature Conservancy	Other Nonprofits	USA
U S Department of Energy	Other Organizations (foreign or domestic)	USA
US EPA	Other Organizations (foreign or domestic)	USA
USGS	Other Organizations (foreign or domestic)	USA
University of Kansas	Academic Institution	Lawrence, KS

Full details of organizations that have been involved as partners:

Colorado State University

Organization Type: Academic Institution
Organization Location: Fort Collins, CO

Partner's Contribution to the Project:
Collaborative Research

More Detail on Partner and Contribution: Dr. Alan Knapp (Biology Department, Colorado State University) collaborates on many aspects of the Konza LTER program. His research includes studies of grassland ecology, plant ecophysiology, responses to climatic variability and climate change, and the ecology of plant invasions. Knapp's LTER research is supported by a subcontract to Colorado State University,which also provides support for students participating in cross-site research that utilizes the Konza Prairie LTER site and database. Dr. Melinda Smith is an LTER collaborator and participates in several aspects of Konza LTER research, including studies of plant community dynamics, the ecology of plant invasions, genomic responses of plants to climate change, and comparisons of the ecology of North American and South African grasslands. Dr. Smith and her students also oversee the NutNet project at Konza as apart of a multi-site study of the effects of nutrient amendments and herbivory on herbaceous community and ecosystem dynamics. The Konza LTER program provides a subcontract to CSU and logistical support for these studies.

Kansas State of

Organization Type: State or Local Government
Organization Location: Topeka, Kansas

Partner's Contribution to the Project:
Financial support

More Detail on Partner and Contribution: The state of Kansas provides an operating budget for Konza Prairie Biological Station personnel and general site maintenance.

National Oceanic and Atmospheric Administration (NOAA)

Organization Type: Other Organizations (foreign or domestic)
Organization Location: USA

Partner's Contribution to the Project:
In-Kind Support
Facilities

More Detail on Partner and Contribution: Konza Prairie is part of the U.S. Climate Reference Network (USCRN). USCRN is a network of climate stations developed as part of a National Oceanic and Atmospheric Administration (NOAA) initiative. Its primary goal is to provide future long-term homogeneous observations of temperature and precipitation that can be coupled to long-term historical observations for the detection and attribution of present and future climate change.

Have other collaborators or contacts been involved? No

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The Konza Prairie LTER Program is a comprehensive, interdisciplinary research program designed to contribute to synthetic activities and conceptual and theoretical advances in ecology, and to further an understanding of ecological processes in mesic grasslands. Examples of specific recent contributions to the discipline of ecology are provided in the attached 'Konza LTER Findings' file. Here, we summarize in more general terms the contributions of the Konza LTER program to the advancement of ecology. Konza LTER scientific findings continue to be published in a broad range of high quality journals. In the 2013-2014 period, the KNZ program produced or contributed to 110 publications: 89 refereed journal articles (including 18 currently in press), 5 book chapters, and 16 dissertations and theses. These publications cover topics ranging from the ecophysiology of individual organisms to regional patterns of productivity to consequences of global change in grasslands. Konza LTER scientists continue to publish articles in both disciplinarily focused and more general high impact journals (e.g., Nature, Science, PNAS, BioScience), reflecting significant contributions to the field of ecology. In addition to site-based science, Konza publications include substantial contributions to multi-site, collaborative ecological research, and the widespread use of Konza LTER data and resources by the broader ecology community. For example, Konza LTER data were used in several recent multi-site or synthetic efforts, such as: a meta-analysis of long-term experiments of ecosystem sensitivity to chronic resource alterations (Smith et al. in press); a cross-site study of scale-dependent responses of soil fauna to soil water availability (Sylvain et al. 2014); a regional study of effects of seed source (local ecotypes vs. cultivars) of ecosystem processes in restored grasslands (Baer et al. 2014); a cross-site study of grassland community responses to spatial vs. temporal variability in precipitation (Cleland et al. 2013); and a cross-site assessment of differential sensitivity of grassland productivity to regional drought in the western US (Knapp et al. in press).

What is the impact on other disciplines?

The Konza Prairie LTER program and our core research experiments attract numerous scientists from a broad spectrum of scientific disciplines beyond ecology. For example, a hydrogeochemist from the University of Kansas (Gwen Macpherson) is a long-term collaborator in the Konza Prairie LTER program, and we support ongoing long-term studies of groundwater chemistry sampled via permanent wells located on Konza Prairie. An atmospheric scientist from the University of Kansas (Nate Brunsell) uses Konza sites to study the effects of surface heterogeneity on land atmosphere interactions, and is employing a Large Aperture Scintillometer (LAS) to measure sensible heat fluxes over longer path
lengths that span Konza watersheds with ongoing C flux measurements. This allows comparison with eddy covariance stations and satellite derived estimates of surface energy fluxes. In the past year we collaborated with a soil scientist (Francesca Cotrufo) and her students (Colorado State University) to assess patterns and controls of soil carbon dynamics. Another soil scientist from Cornell (Johannes Leahman) used Konza LTER treatments to assess the impacts of landscape position and contemporary management practices on black C accumulation in soils. A hydrologist from Biological and Agricultural Engineering (Stacy Hutchinson) is collaborator on the 'Irrigation Transect Experiment', and has provided numerous training opportunities for Biological and Agricultural Engineering and Hydrology students. Konza Prairie has also become a research platform for several collaborative teams of ecologists and molecular biologists that are part of the KSU Ecological Genomics Initiative. Many of these interdisciplinary teams are using the Konza LTER site and associated long-term experiments to address questions related to the genetic mechanisms underlying plant and animal responses to environmental constraints. The KNZ LTER patch-burn grazing experiment is being done in collaboration with Dr. KC Olson, a grazing animal nutritionist that is using the experiment to assess the impacts of alternate grassland management practices on animal nutrition and animal health. Other contributions to disciplines outside the traditional realm of ecology include the operation of flux towers at the Konza site, which has provided data used by micrometeorologists, climatologists, remote sensing scientists and modelers. We also collaborate with atmospheric chemists and modelers from the EPA CASTNet program in sampling concentrations of selected airborne particles and using these to model dry deposition rates, and in 2006, two new seismographs were installed on the site to facilitate ongoing geologic research by USGS scientists and their collaborators. We also collaborate with NASA scientists in the
maintenance and operation of a Cimel sun photometer at the Konza site.

What is the impact on the development of human resources?

The Konza Prairie LTER VI program makes significant contributions to human resource development in science, engineering and technology. Our program continued to contribute to the training of undergraduates directly (REU students and others) and indirectly (through the use of Konza LTER data in ecology classes and text books). As documented elsewhere in this report, we also train numerous graduate students, and provide valuable experience in interdisciplinary research and the synthetic use of long-term datasets. In addition to supporting KSU graduate students, the Konza Prairie LTER site is widely utilized by graduate students from other institutions. During the current funding period, the site has been used by graduate students from the University of Kansas, University of New Mexico, University of California - Santa Cruz, Southern Illinois University, Colorado State University, Yale University, and several others. We also hosted field trips for students from many regional colleges and universities, and in the last year we hosted a summer student training field trip organized by Haskell Indian Nations University. The Konza Environmental Education program, and the Konza Prairie Schoolyard LTER Program, provide formal and informal research experiences and science education to public groups, children and K-12 teachers, as well as training experience for a graduate student in the College of Education. Konza LTER research in restoration ecology was used by local high school teachers to develop educational activities as part of Howard Hughes funded teacher training program. KNZ PI Blair served as consultant and advisor for a local high school teacher (Shane Neel), who is establishing an educational prairie restoration research site as part of his Masters of Education degree program. Finally, the Konza LTER site continues to be used in conjunction with the NSF-funded Girls Researching Our World (GROW) program (www.ksu.edu/grow/), with several KSU scientists and students leading educational activities for 7th and 8th grade girls.

What is the impact on physical resources that form infrastructure?

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The Konza LTER program provides a research platform for scientists and students from around the world. The 3,487-ha Konza Prairie Biological Station (KPBS), located in the Flint Hills of NE Kansas, is the core research site for the KNZ program. In addition to providing the watershed-level fire and grazing treatments, agricultural fields, restored prairie, stream network and weirs, KPBS includes several buildings in the headquarters area that support LTER research. The on-site Ecology Laboratory (2,400 ft2) includes (1) a wet/dry lab with sinks, fume hood, refrigerators, balances, etc., (2) two large

multi-purpose work rooms with bench space and sinks for processing samples, drying ovens, refrigerators and freezers, and equipment storage, and (3) and a large researchers' shop equipped with a variety of tools and field supplies. Other station buildings include a fire station and maintenance building, a large storage building for equipment, and a residence occupied by the site foreman year round. The 4,650-ft2 Hulbert Center houses a library/conference room, administrative offices, classroom and teaching laboratory (used primarily for K-12 activities), reference herbarium and animal collections, and a kitchen and dormitory-style housing for 15 visitors. Two small guest cottages (each with 2-bedrooms living room, bath, kitchen, and laundry facilities), can accommodate up to 5 persons/cottage. A larger cottage, built in 2012, can accommodate up to 12 guests, expanding the capacity of on-site accommodations to 37 visiting researchers.

With support from an NSF Field Stations and Marine Laboratories (FSML) grant, Kansas NSF EPSCoR, the Kansas Agricultural Experiment Station, KSU, and private foundations, several major site improvements and building renovations were completed during LTERVI. These include new housing for visiting students and scientists (included above), an on-site meeting and conference center, and improved Internet capabilities. With funding from an NSF-FSML grant and additional support from KSU and a private donor, an historic limestone barn at the KPBS headquarters was transformed into a multipurpose meeting facility for on-site conferences, workshops, and educational programs. The historic stone barn was renovated in 2008 and has the Cortelyou Lecture Hall (1,750 ft2) with a seating capacity of ~100 persons fully equipped with A/V equipment and wireless internet. An additional large multi-purpose room (1,850 ft2) is designed as flexible space for varied uses including additional meeting space, workshops, scientific posters and other research displays, social gatherings, and education programs for large groups. All lab and office buildings at KPBS have T1 Internet connectivity to the KSU campus. In addition, there is a wireless link to KPBS from campus with multiple wireless access points (802.11abg) that provide coverage to >60% of the 3,487-ha site.

Other LTER infrastructure, maintained by KPBS, includes the outside perimeter fence (29.8 km), the interior bison management area enclosed by 16.4 km of "New Zealand" fence, 98 small (25-m2) grazing exclosures, 11.7 km of fence for cattle research, 26.4 km of access roads and 61 km of fireguards separating the experimental watershed units. KPBS maintains several general-purpose vehicles on-site, as well as specialized equipment (tractors, fire trucks, mowers, soil augers, etc.). KPBS makes staff and equipment available to assist with KNZ research activities, including mowing fireguards, installing equipment, soil coring, etc. KPBS staff also coordinates the fire management plan and implementation of prescribed burning of watersheds and experimental plots, and the management of bison and cattle herds for KNZ grazing treatments. The headquarters area include a corral and handling facilities for managing the bison herd (hydraulic chute, electronic scales, etc.), which is essential for LTER grazing studies. Other field equipment and instrumentation on site includes the main KNZ weather station, a network of 11 rain gauges, two eddy flux towers for quantifying ecosystem-level C and water vapor flux, four weirs and associated stream gauging equipment (updated in 2012 to Sutron Constant Flow Accubar® bubble gages and recorders with wireless connectivity), 46 wells for measuring groundwater levels and chemistry, numerous TDR probes, neutron access tubes and tension lysimeters for soil water measurements. Related equipment co-supported by other programs includes a USGS stream monitoring station, a NASA CIMEL Sun Photometer, 2 seismometers (USGS), an aerosol and ozone monitoring facility (CASTNet), and a NOAA Climate Reference Network (CRN) weather station. These facilities add significantly to data for LTER research and education programs, and for regional and cross-site studies. KPBS is also a core site for National Ecological Observatory Network (NEON), which will begin construction of major research infrastructure in summer 2014. NEON will provide additional unique measurement capabilities and data at KPBS, which will complement many KNZ LTER studies.

In addition to facilities at KPBS, a wide-range of modern laboratory facilities are available on the nearby KSU campus approximately 15 km from KPBS (*e.g.,* Analytical Chemistry Labs, Stable Isotope Lab, Center for Ecological Genomics, Core Sequencing and Genotyping Facility, Lipodomics Center, Gene Expression and Microarray Facility, a BioSafety Level 3 Facility for invasive species and infectious disease studies, etc.). The majority of core LTER laboratory space and analytical equipment are located in Bushnell Hall (Biology), including space and equipment for preparing plant, soil and water samples for analysis (drying ovens, grinders, shaker tables, block digestors, vacuum filtration systems). Two walk-in controlled environment chambers (Conviron PGV 36) are located in Bushnell Hall and available for LTER use. Bushnell Hall also houses an extensive collection of prairie plant specimens in the KSU Herbarium, and these specimens are now electronically databased and georeferenced. Some specific equipment and facilities available for LTER research are located within other Departments (Agronomy, Biological and Agricultural Engineering, Plant Pathology, Geography), reflecting the interdisciplinary nature of our research. Some major analytical instruments available for KNZ investigators include: 2 Alpkem autoanalyzers (FlowSolution IV) for liquid samples, Carlo-Erba 1500 automated C/N analyzer for solid samples, Shimadzu TOC 500 analyzer for dissolved C, a Hitachi U2900 automated dual-beam spectrophotometer, several gas chromatographs with electron capture, flame ionization and thermal conductivity detectors, a Nikon compound microscope with epifluoresence and video imaging capabilities, 4 LiCor 6400 Portable Photosynthetic Systems, 2 LiCor 8100 systems dedicated for soil CO2 flux measurements, a LiCor 1600 null-balance porometer for stomatal conductance, and 3 pressure chambers (PMS model 1000) for measuring plant water potential, 4 Tektronix cable testers (model 1502B) coupled to Campbell CR10 data loggers for TDR soil moisture measurements, 2 Troxler (model 3221) neutron probe gauges for soil moisture determinations, a back-pack mounted minirhizotron (Bartz Technology Co) camera system, and Trimble GPS units. Eight multi-parameter sonds (YSI 6000) are used for monitoring oxygen and temperature in 3 watersheds. Cold storage facilities for holding samples are available, as are sample preparation rooms for drying and grinding plant and soil samples. Climate controlled greenhouse space is available on the KSU campus. In addition, other "typical" laboratory instruments (balances, microscopes, etc.) are available in individual investigator laboratories.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?

KNZ resources are used to support the hardware and software associated with the KNZ web site and data portal.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

The Konza Prairie LTER program contributes to increased public awareness of ecological and environmental issues (e.g., biodiversity conservation, habitat loss, ecosystem services, restoration ecology, etc.) through outreach and public education activities, such as the Konza Prairie biennial Visitors' Day and our docent-led public education programs. For example, in 2014 NPR reporter Dan Charles visited the Konza Prairie

LTER site and interviewed LTER scientists John Blair and John Briggs for a story that aired nationally on Morning Edition on April 28, 2014. The story focused on the role of fire in management and conservation of tallgrass prairie, particularly in the Flint Hills region. Konza LTER scientists also conduct an annual fire-training course for researchers and local land managers (35-40 participants/year). In addition, the Konza LTER Program is increasingly called upon to provide data relevant to resource management and regulatory policy. At a local level, Konza scientists continue to serve as consultants for the Flint Hills Discover Center, and we participate in Kansas Agricultural Experiment Station public education events by providing information on the ecological consequences of various grassland management practices (e.g., fire frequency and grazing). At the regional level, Konza Prairie scientists are advising EPA Region 7 staff and scientists on the ecological benefits of fire in maintaining native tallgrass prairie habitat and diversity and contributing important long-term data to guide the development of the Flint Hills regional smoke management plan. This issue has become very important, as the potential impacts of grassland burning on regional air quality have been receiving increasing scrutiny. Konza grazing studies are also providing data that will inform ranchers and land managers of the potential benefits of alternative management strategies. In the international arena, Konza Scientists have provided information on grassland management to scientists and park resource managers from South Africa, Australia, and Hungary, with many of these visits focusing on resource management issues of public concern. The Konza Prairie LTER database is also being used to address other issues relevant to regulatory policy. Long-term data on Konza Prairie streamwater quality is providing a baseline for regional water quality in the absence of agricultural practices or other disturbances. LTER data on soil chemistry is also being incorporated into ongoing studies to evaluate the potential of grassland management practices to increase soil C sequestration to offset atmospheric CO2 loading. Finally, the Konza Prairie LTER site, and the unique watershed fire and grazing treatments, have been the focus of several art- and humanities-related activities. For example, the Konza Prairie Biological Station continues to provided on-site housing for a Visiting Writers series, in conjunction with the KSU English Department, as part of KNZ's contribution to the LTER Ecological Reflections program. In 2014, the visiting writer was Camille Dungy, who has received national attention for the volume *Black Nature* which she edited. Also in 2014 an interpretive dance piece ("Moving for Monarchs: The Awakening") was filmed at the KNZ LTER site. This was aimed at using dance to increase public awareness of an important environmental issue. The dancers and artists, in conjunction with the non-profit conservation organization MonarchWatch, aim to "make visible the critical challenges facing monarchs and other pollinators" and inspire grass roots action towards conservation goals.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.